Influence of Transportation Changes on Urban Land Uses and Values

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● THE REVOLUTION in transportation methods has been pointed to as the most significant factor affecting the structure and economic well-being of urban communities in the twentieth century. Meanwhile, little is known concerning the actual effects of changes in transportation on urban land uses and land values. Today, highway planners, appraisers, real estate brokers, local planning officials, and the general public ask, "What is the effect on land uses and land values of current programs of highway construction?" Highway right-of-way agents are interested in determining the influences of limited-access highways on adjacent land and the over-all impact of highways on land values. Appraisers are concerned with the impact of highway development on adjacent and nearby property. Real estate brokers and land developers seek to analyze highway impacts on land development and investment prospects. Metropolitan planning bodies must consider the probable influence of highway development as a basis for future master planning. City and county officials are concerned with the impact of highway development on property values which serve as the local tax base.

Although much research has been carried on in recent years by state highway authorities, universities, and others under the auspices of the Highway Research Board and other research groups, the problem of analysis is extremely complex and the results thus far permit only limited generalization.

The objectives of this paper are threefold:

1. To review and evaluate present theories of urban land values with particular reference to a recent exchange of views regarding the effects of transportation changes on land values.
2. To summarize the empirical evidence on urban land value trends.
3. To describe some new research approaches to the analysis of the influence of transportation on urban land uses and values.

REVIEW AND EVALUATION OF PRESENT THEORIES OF URBAN LAND VALUES

Economists are in general agreement that urban land values represent the present value of expected future net returns attributable to land (site rents). It is evident that the determination of urban land values in the market under this theory implies the capitalization of future expected urban land rents by investors, employing selected capitalization rates. This observation highlights the importance of the element of investor psychology and expectations as influences on the determination of land values in the market place.

The classical economic rent theory, which had its roots in Ricardo's rent theory based on differential fertility of soil, holds that site rents result from superior acessibility advantages and that the owners of the relatively accessible sites will impose a rental charge equal to the saving in transportation costs which the use of their sites makes possible. Haig (1, pp. 38-40) in his exposition of this theory, points out that general improvements in transportation or specific developments which make it easier or cheaper to get to or from the center of the city would decrease the relative accessibility advantages of central sites and hence reduce total urban site rents and land values.

Haig's analytical framework and conclusions have been accepted by virtually all

land economists. Based on this general theory, Dorau and Hinman argued that increasing the speed and decreasing the cost of transportation would result in an increase in the supply of urban sites by bringing more land into utilization. Thus, extending the city's boundaries by transportation improvements would increase the supply of sites, reduce the relative accessibility advantages of central locations and lower total land values.

From the same premises, Ratcliff (2, p. 129) argued that an increase in bus fares to the central city from the suburbs would tend to increase total urban land values and that, conversely, the improvement in transportation resulting from the spread in the use of the private automobile has tended to reduce land values in the central areas by making outlying retail centers more generally accessible.

These and other analyses based on Haig's theory, failed to give adequate consideration to the highly important assumptions underlying Haig's theories. Further, in many cases, the distinction between the effect of transportation improvements on downtown commercial site values and total urban land values has not been explicit.

The implications of some of the conclusions which have been drawn for public transportation policy are surprising, if not alarming. If one accepts the conclusions which appear to have been drawn by Haig, Ely, and Ratcliff concerning the probable effect of transportation improvements on land values, without considering the limiting assumptions underlining their theories, any city desiring to preserve its land values as a tax base would oppose improvements in transportation.

Serious shortcomings can be observed in the attempts to apply classical price and rent theories to urban land valuation problems. The author has concluded that many accepted urban land valuation theories represent little more than unsubstantiated hypoteheses and at best are abstract and theoretical formulations based on highly unrealistic assumptions (3, p. 240).

In an attempt to develop a more useful framework for analyzing urban land values, the author has classified the principal factors influencing the aggregate of land values in a city. This theoretical reformulation of a theory of land values represents aggregate land values in a city as the present value of the expected future returns to urban land. A theoretical model of the factors influencing urban land value trends focuses attention on major determinants of urban land values in the following equation:

$$\text{Aggregate Value of Urban Land} = \frac{\text{Average Future Expected Aggregate Net Annual Urban Land Rent}}{\text{Capitalization Rate}}$$

It should be emphasized that, inasmuch as land values are based on investor's opinions which in turn are based on expectations, investor psychology is an important influence underlying urban land value trends. Three sets of factors are identified as influencing the value of urban land based on the foregoing conceptual model.

1. Factors influencing expected revenues to urban land: changes in population, consumer incomes, and total demand for urban services, competitive pull of other areas, supply of land, and prospective and actual investment in public improvements.
2. Factors influencing costs as an offset to urban land revenues: changes in local property taxes, operating and management expenses, interest on capital invested, and depreciation allowances.
3. Factors influencing the rate of capitalization applied in the real estate market to expected net returns from urban land: changes in interest rates, expectations of risk, and capital gains.

This analytical framework focuses attention on the complexity of factors influencing urban land value trends. Specifically, it draws attention to the fact that improvements in transportation to and from urban centers not only have the effect of adding to the supply of competitive land, but at the same time result in an increment to the population served and hence to the demand for urban land and its services.

Ratcliff (4, pp. 360-362) argues that this approach "adds little to our understanding of urban land values." He accuses the author of employing the "straw-man device" in his criticisms of urban land value theories and with missing "the obvious intent of

Ely and Haig to state in hypothesis from a simple cause and effect relationship clearly restricted to a general tendency under limiting conditions". For reason outlined in the following, Ratcliff's rejoinder cannot be accepted as invalidating the criticisms of classical theories as trite and unrealistic.

Specifically, the implicit assumptions in the theories of Ely, Haig, and Ratcliff that "other things remain the same" are not only unwarranted, but also illogical. Where A (a change in transportation) is associated with B (change in demand for urban land) and in C (change in supply of urban land), and where these influences have a combined effect on urban land values, one should not (even in theory) postulate changes in C without recognizing that changes will occur in B also. The unrealistic nature of Haig's theory becomes apparent when the implicit assumptions postulated in the phrase "other things remain the same" are made explicit, as in the following restatement:

> Assuming that accessibility to the center of the city is the only criterion for both residential and business location, that all urban sites are substantially homogeneous, that total transportation costs are minimized by locating at the city's center, site rents and land values will tend to be highest in the center of the city.
> Under the above assumptions, general improvements in transportation might result in a decline in the value of sites in the center of the city, provided that they are not accompanied by an increase in travel to the area or any other increase in the demand for services of central area sites.

The assumption of ceteris paribus in the Haig analysis presupposes a "closed" urban area with constant population and incomes. However, it must also assume something about the relative elasticities of the demand and supply curves for transportation if an improvement in transportation is to result in a lowering of aggregate site values. If the effect of improving transportation is to increase the movement of people and the demand for urban services, it can be expected that even in a closed system such as that postulated by Haig, aggregate land values may rise with improved transportation. The relationships between transportation improvements and aggregate site rents under varying conditions of demand and supply elasticity can be conceived in the following manner.

The basic economic service provided in any city is the service of "getting you there." The place you want to go may be to your job, your church, shopping, or any of a great many objectives. This service may be called the "providing of trips" though it is understood that it is not the trip in itself which is wanted but rather what lies at the end of the trip.

Land and transportation are two factors of production which supply trips in the sense used here. If land is highly accessible little transportation is needed to "get you there."

If land is poorly accessible much transportation is needed. Haig refers to the cost of "getting you there" as the costs of "friction."

In Figure 1 the vertical axis represents either the price per trip which buyers would be willing to pay for different quantities of trips or the cost per trip at which suppliers would be willing to supply. The horizontal axis represents quantity demanded or supplied.

The demand curve indicates that buyers are willing to buy more of the basic service provided the price per trip is reduced. This means that at lower prices they may not be so careful about ganging up working and shopping trips; they may make some trips which otherwise would be too long, etc.

The postively sloped supply curve, mp' represents the transportation charge for providing the quantities and kinds of trips demanded. It indicates that generally speaking, as the number and distance of trips are increased, the cost per trip increases. The basic assumption is that substantial increases in the number of trips are accompanied by increases in distance traveled per trip.

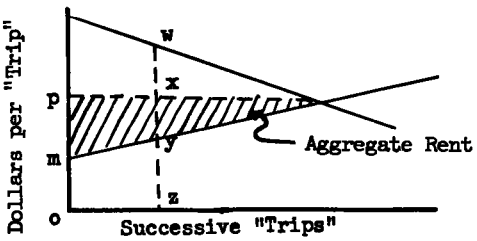


Figure 1.

The market price and quantity are determined at point p'. At this point the value of the last trip demanded is just equal to the transportation cost in providing it. Then line p-p' is the price line for all units of the service.

The width of line wxyz represents one trip. For this particular trip the demand curve indicates that buyers are willing to pay the amount zw. Actually they only pay xyz, for that is the market price. But of the market price the cost of transportation is only zy—for this trip. The remainder, yx, is taken by land. Why does land take this residual? The land involved is so situated as to make possible the relatively low transportation cost zy. Then the rent to land is the whole area pp'm. This is aggregate rent.

Suppose the transportation system is improved. Line mp' becomes line m'p'''. The new price becomes op''. The new aggregate rent to land becomes p''p'''m' (Fig. 2).

The new rent to land may be either greater or less than before, depending on the elasticities of demand and supply.

The more inelastic the demand and the more elastic the supply becomes, the greater is the tendency toward a reduction in the aggregate rent to land as a result of an improvement in transporation as shown in Figure 3. The more elastic the demand and the more inelastic the supply becomes, the greater will be the tendency to an increase in the aggregate rent to land as a result of an improvement in transportation. This is illustrated in Figures 3 and 4.

Actually, relatively little is shown at this time about the elasticities of the demand and supply curves for transportation. It is clear, however, that the conclusion that an improvement in transportation will result in a decline in aggregate rents and hence in land values, represents a special case, and one that is unlikely to occur.

An absolutely inelastic demand curve for transportation to the center such as that postulated in Haig's theory is virtually inconceivable. Any improvement in transportation which increases travel by an existing population, or extends the boundaries of the area served by the center of the city, is certain to increase the number of trips by some amount, and this amount will be larger as the relative elasticity of the demand for transportation services is increased. The prospects of an upward shift in the demand for trips with any improvement in transportation are magnified by the fact that transportation improvements are usually made in response to an increased demand. Although the author is not prepared to present empirical evidence of the increases in travel to the center of American cities with the improvements in auto transportation facilities during the past decade, he is certain that transportation engineers will need little convincing that the price-elasticity of demand for trips may be high.

When these and other limitations of Haig's theory are carefully considered, it is apparent that one should not draw conclusions concerning the practical effect of a change in bus fares or of other transportation facilities on land values within the framework of his partial analysis.

The assumption that all urban sites are relatively homogeneous further vitiates the use of the classical analysis. In one sense, the supply of urban land is unlimited, inasmuch as virtually all cities can expand in some direction. In another sense it can be argued that urban sites

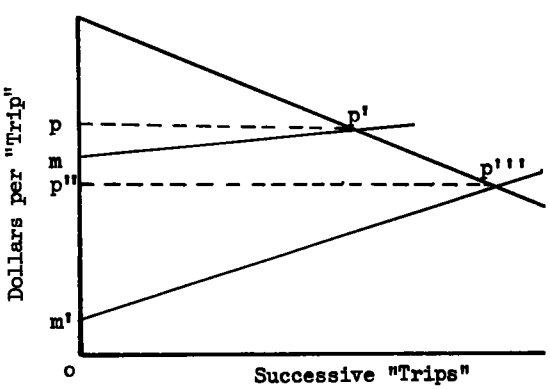


Figure 2.

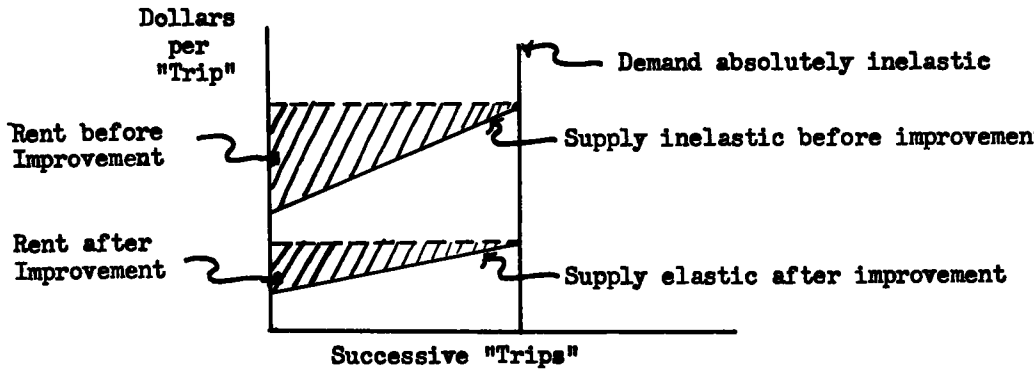


Figure 3.

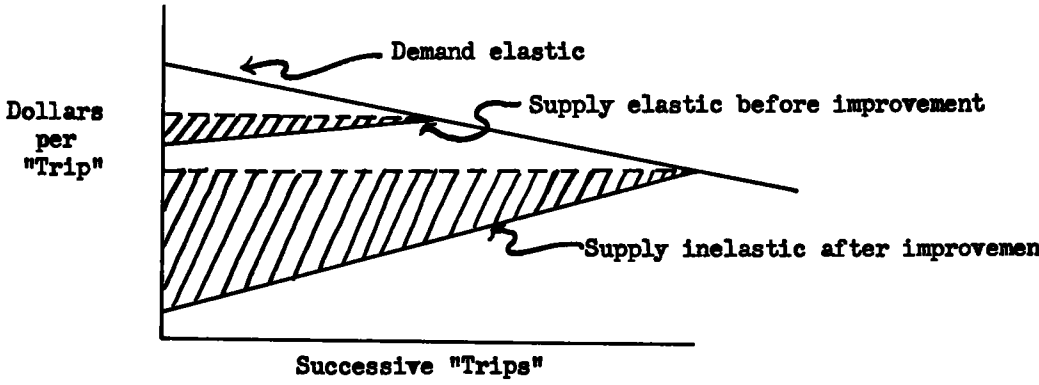


Figure 4.

are highly differentiated and that the urban land market is distinctive. Linkages between various types of activities which impede shifts in location are an important factor influencing differentiation of real estate markets. The effects on such markets of increments to supply are quite different than if land units were identical. Improvements in transportation must be viewed, therefore, in the light of their particular effect on various submarkets rather than on the urban land market as a whole. Freeway construction, for example, may result in major additions to supply of residential land without increasing the supply of commercial or industrial land. Zoning, of course, and the tendency for complementary uses to be "linked" together contribute to site differentiation and to the compartmentalization of different segments of the real estate market.

The argument that the principles of monopolistic competitive pricing rather than pure competition pricing prevail in the urban land market has been misinterpreted by Ratcliff (4, p. 362). He fabricates his own "straw man" in attributing to the author the view that urban property owners have "monopoly" control over the supply of urban land. Because of this misinterpretation, most of his discussion has no bearing on the central argument that increments to the total supply of urban land may have limited effect on downtown commercial site values because of the highly differential character of urban sites and the existence of distinct submarkets.

The importance of the fact that the urban land supply is differentiated into various submarkets can be observed in Figure 5, which represents the supply of land with

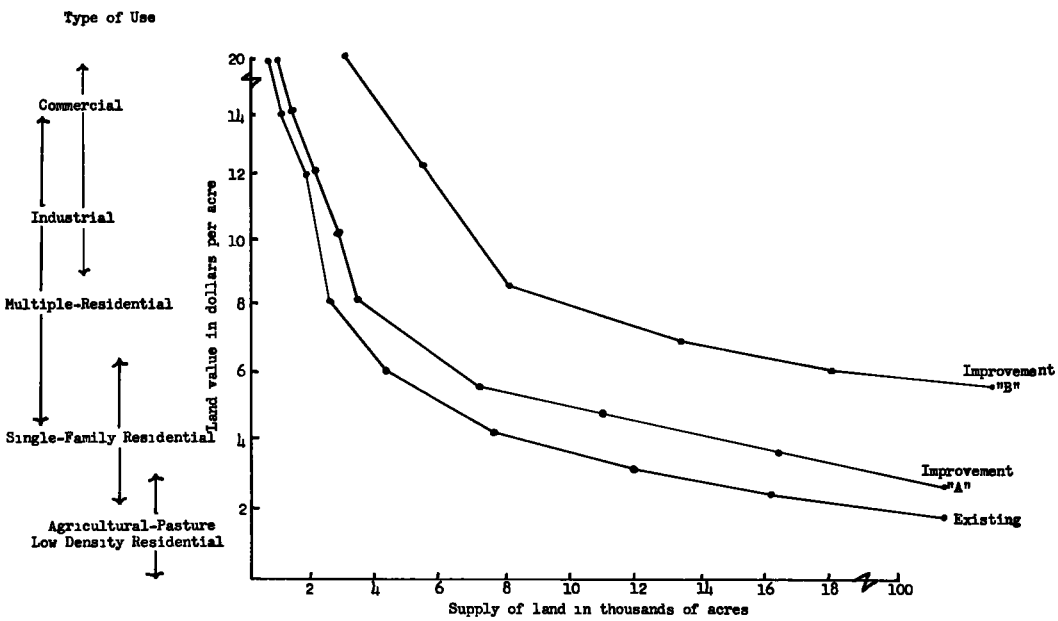
various accessibility advantages at three time intervals. The existing supply curve shows a relatively limited supply of sites with high accessibility features and hence high dollar values per acre. The supply of low-density residential land is, of course, much larger in amount and lower in value per acre. An improvement in transportation "A" (freeway construction), may result in a large increment to the supply of land suited to residential subdivision, but may not add appreciably to land suited to commercial and industrial uses. A different type of transportation improvement "B" may, however, add substantially to the supply of land with accessibility advantages suited to commercial use. Differences in the characteristics of land and in relative accessibility advantages contribute to the difficulty of generalizing concerning the effects of any given change in transportation on urban land values.

Although Ratcliff acknowledges the central premise that Haig, Ely, and others do not "set forth a comprehensive theory of urban land values" and that their analysis was "clearly restricted to a general tendency under limited conditions," he offers no explanation for the fact that he and others have employed such a restricted and noncomprehensive theory to draw conclusions regarding influences of transportation changes on land values that appear both illogical and indefensible.

Ratcliff's comment that "Professor Wendt is, of course, thinking in terms of the net effect (of transportation changes) which is quite another concept," is a partial recognition of the shortcomings in earlier analyses. It is indeed comforting to find that he agrees that "whether the total effect of all factors is a decline (in values) can be determined only by empirical methods." On this note of agreement, a review of the evidence concerning recent trends in urban land values follows.

Urban Land Value Trends

Well-organized data describing trends in urban land values in the United States are lacking. Any conclusions drawn, therefore, must rest on the pioneering work of Hurd and Hoyt during the period from 1900-1933, supplemented by more recent studies in a relatively few major cities. A limitation on interpretation of research results arises



A - Improvement in transportation - expands supply residential land

B - Further improvement - commercial and multi-family uses Expand into outlying areas

Figure 5.

from the uneven quality of the basic data employed in various studies, because some rely on assessed values, whereas others are based on relatively small samples of market sales. Further difficulties arise from the fact that many of the existing studies are confined to land value trends in specific areas of cities, preventing descriptive analysis of changes in total values or of the internal structure of values within cities or metropolitan areas.

Notwithstanding these limitations, broad trends in urban land values can be described. Recent studies confirm the findings of Hurd and Hoyt that urban land values rose quite rapidly during the first quarter of the 20th century, culminating in a speculative peak in the late 1920's. Commercial land in the central business districts of the larger cities rose to particularly high levels during this period, although land speculation resulted in rapid increases in outlying commercial and residential land as well. Following a disastrous period of liquidation and foreclosures during the Great Depression, urban land values rose gradually in the prewar years, and more rapidly during and immediately following World War II, under the stimulus of high rates of urbanization and business property (5). By 1950, urban land values in the central business districts of some larger cities had recovered to the previous speculative peaks of the 1920's, although values appear to have risen more slowly in New York, Chicago, and a few other of the largest cities. Since 1950, land values in the central business districts of most large cities have risen further, accompanied by relatively high levels of commercial and office building activity. Rising local property taxes have constituted a "drag" on urban land values generally.

Recent studies of urban land value trends in the San Francisco Bay Area (7, 8) revealed that total Bay Area urban land values have probably more than doubled since the peak of 1929-30. The percentage increase in land values was substantially greater in outlying commercial and residential areas than in the central areas of San Francisco or Oakland. Value increases during the postwar period were most striking, of course, in the newly developed commercial areas and shopping center locations. Although land values rose in both the central core and in the suburbs, striking differences in urban land value trends were noted within different parts of both central and outlying areas.

The dynamics of change in the structure of urban land values adds greatly to the difficulties of generalizations concerning trends. It is apparent that a general rise has occurred in the aggregate current dollar value of urban land values in the San Francisco Bay Area. Because of the more rapid rate of increase in land values in the outlying areas, the percentage of total increase in land values appears greater as the area included is increased in size.

Although these views cannot be supported with well-organized statistical data it is believed that distinctive trends can be observed in various Bay Area submarkets for urban land in the past decade. Rising values in the office building sections of the larger cities have been accompanied by lagging value trends for some downtown and string street retail store sites, and rapidly increasing values for newly developed retail areas. Meanwhile, booming values for sites suitable for high rent apartments or hotels have been countered by a relatively stable trend for other residential land within central areas. The impact of Federal subsidies for urban renewal programs has gradually been reflected in higher land values in selected slum areas. High rates of tract building in the suburbs have resulted in lot prices in many outlying areas equaling or exceeding those in more central locations. Little evidence can be found for a gradient of land values from the center to outlying areas in today's market.

These apparently diverse trends reflect in part imperfections in the real estate market apparatus, but to a degree they also support the view that urban sites are highly differentiated and enjoy narrow and specialized markets. Changes in the aggregate of urban land values in the Bay Area, therefore, cannot be identified as resulting from a total increment to supply, but rather from the totality of increments to both demand and supply for various sites having particularized accessibility and other advantages.

It is arguable whether a real rise has occurred in urban land values since 1939, after adjusting for changes in the value of the dollar. Because urban land values have risen more rapidly in outlying suburban areas, the conclusion reached might depend

on the size of the geographical area included. There can be little doubt, for example, that total urban land values have risen substantially in constant dollars in the San Francisco Bay Area, in Los Angeles County, or in the New York Metropolitan Region over the peak level of the 1920's. It is probable, however, that the value trends in the City of San Francisco or New York would show a lesser increase, because values have risen more rapidly in outlying suburban locations.

The double peaks in land values reached in the 1920's and the 1950's adds to the difficulty of describing long-run trends in urban land values. The trend appears clearly upward if the researcher accepts the year 1900, 1940, or 1950 as a base, but the slope of the long-term trend line in urban land values is quite different if he uses the high levels of the 1920's as a base period.

Few systematic studies have been made of the relationship between transportation changes and land values. Research in the San Francisco Bay Area suggests that the influence of increments to the supply of urban land resulting from improvements in transportation are much more complex than assumed in classical economic analysis. Improved freeway transportation has undoubtedly been a factor influencing the more rapid rise in urban land values in outlying suburban areas. One might also conclude that the expansion in auto transportation has restricted the expansion in central city land values that would have occurred in the absence of extensive highway development. A decline in some central city functions can be observed. The results of the United States Census of Business for 1954 reveal, for example, that the percentage of total retail sales accounted for by cities with 100,000 or more inhabitants declined from approximately 43 percent in 1939 to 38 percent in 1954 (9, p. 307). This observation, however, obscures the relatively large absolute increase which has taken place in retail sales in central cities, and takes no account of the expansion in administrative, financial, and tourist functions. It thus reflects the relative change in demand for only one type of urban service performed by central cities and may have been offset by an increasing dominance of the central city in the furnishing of many other types of business services.

The complex structure of urban land values and the constant shift in the internal structure of urban land values restricts generalization concerning value trends. One might be justified in concluding that the combined influence of improved transportation and other factors present during the postwar decade has been to result in a major expansion of urban areas, an increase in the demand for all urban services and a rise in land values in the central business districts, central cities as a whole, and in outlying residential and business locations.

Increases in aggregate urban land values in the San Francisco Bay Area during a period of rapid expansion in urban facilities for auto transportation suggest that any declining value influences resulting from the increase in supply of competitive urban land have been more than offset by expanded demand for urban land and its services. This observed trend would appear to confirm the earlier hypotheses that increments to the supply of urban land are usually accompanied by concomitant demand increments. In some sense, it can even be argued that increases in demand appear to bring about the increases in supply, rather than to follow.

Lessinger, of the Real Estate Research Program, is developing a comprehensive methodology to forecast the impact of highways on urban land use and values. Certain aspects of the method are in process of being tested in the nine-county San Francisco metropolitan area. The following brief account of the tentative method is necessarily oversimplified. There are eight essential points, as follows:

1. An economic concept of the metropolitan area is adopted to provide a land market within which highway impacts are considered.
2. Land use impacts are put in terms of different "rates of urbanization." The rate of urbanization is the number of acres urbanized over a period per 100 acres which are suitable and available for urbanization. The rate of residential urbanization is correspondingly the number of acres converted to residential use over a period per 100 acres which are suitable and available. Likewise there are commercial and industrial rates. Different degrees of intensity in each use may also be identified as a basis for determining "rates."

3. Sectors are defined within metropolitan areas on the basis of different rates of urbanization. Suppose an entire metropolitan area is divided up by a grid of very small rectangles. Suppose the rate of residential urbanization is observed for each rectangle. The different rates can be visualized as different "heights" on a relief map. Presumably there will be a series of "hills" and "mountains" formed. These can be represented by a topographic map showing contour intervals. The contiguous area within any two contour intervals is defined as a sector. It is a residential sector if the rates are residential rates. It may be any other type of sector depending on the nature of the rates. Of course a map of residential sectors will be very different from a map of industrial sectors. It should be noted that the sectors are not fixed, but constantly shift in response to a large number of factors.

4. Factors explaining the boundaries of sectors can be organized into four groups: supply of and demand for accessibility, supply of and demand for base-productivity. Accessibility refers broadly to ease of making ground trips from a site to other sites. Base-productivity refers to the ease of producing goods and services at a site. Buildings, views, drainage, and zoning are examples of base-productivity attributes. These illustrate the nonhomogeneity of sites. Incidentally, Lessinger's approach argues against the too inclusive preoccupation with the accessibility factor. In practice it is likely that there are large research benefits from the relative expansion of attention to the base-productivity variables.

5. In contrast to earlier theories, accessibility is identified as a cost schedule to reach wider and wider groupings of jobs, shopping services, and other potentially desired opportunities.

6. A study is carried out to determine for a particular metropolitan area how different accessibilities and base-productivities are associated with the various sectors. Two kinds of products are obtained from this study:

   a. Combinations of accessibility and base-productivity are derived which belong to different sectors.
   b. Projected sectors can be put in an array as to superiority or inferiority for each set of uses.

This kind of study is being carried out in the San Francsico area for residential sectors. The nine counties facing the San Francisco Bay are divided into a grid of more than 35, 000 rectangles. Random points are projected within relevant rectangles, and over 25 types of information are compiled for each. This information bears either on the rate of urbanization or on accessibility or base-productivity.

7. An empirical law of distribution of land uses among the sectors tends to hold. This law is in the following form: the best 10 percent of all the land in the metropolitan area (as determined by the empirical work already described), will obtain x percent of the total acreage in the given land use. The best 20 percent will obtain y percent and so on. This is strictly comparable to the empirical laws of income and wealth distribution in economics which are represented by "Lorenz curves." It is determined from data for a given period, and then assumed to change slowly enough so that it would tend to hold for future periods.

8. Finally, it is desired to project for some future time period, changes in land uses (and ultimately land values) which are due to changes in a highway system and other variables.

   a. Estimate total urbanization of a given type; for example, residential, for the metropolitan area as a whole.
   b. For every site calculate accessibility and base-productivity attributes, given the future highway system.
   c. Future sector boundaries are determined. This depends on the future accessibility and base-productivity attributes, and the relationships between accessibility base-productivity and sectors determined for a past period.
   d. The total estimated acreage of the land use is then distributed over the various sectors in accordance with the empirical law of distribution.
   e. Further periods may be projected by taking the results of initial periods as a feedback.

f. Further refinements may be added: totals may be determined simultaneously with distributions on all levels.

As a result of the methodology developed by Lessinger, the impacts of highways emerge as one facet in a closely connected web of factors. The answer emerges from the reconstruction of the total web of factors. Further impacts may then be sought within the sectors. There, physical proximity to highways and freeways may be most important in differentiating sites.

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